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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/788,889	02/27/2004	Kevin Shea	303.867US1	4555

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EXAMINER	
SULLIVAN, CALEEN O	

ART UNIT	PAPER NUMBER
1795	

MAIL DATE	DELIVERY MODE
12/23/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/788,889	SHEA ET AL.	
	Examiner	Art Unit	
	CALEEN O. SULLIVAN	1795	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 September 2008*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-11,24-34 and 39-42* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-11,24-34 and 39-42* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. Applicant's amendments to claims 1, 7, 24, 29 and 39 have failed to overcome the rejections previously presented in the prior Office Action; therefore, Examiner maintains the rejections below with modifications to address the amendments to claims 1, 7, 24, 29 and 39.

2. Applicant's amendments to claims 1, 7, 24, 29 and 39 have failed to overcome the obvious double patenting rejection presented in the Office Action, dated 05/12/08. However, Applicant has submitted a proper Terminal Disclaimer for Application Serial number 11/494056, which is the basis of the obvious double patenting rejection and has been approved. This terminal disclaimer has overcome the obvious double patenting rejection of claims 1-11, 24-34 and 39-42 of the present application over claims 13-15, 19 and 23-24 of 11/494056; therefore, Examiner has withdrawn the rejection.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. Claims 1-4, 7-10, 24 and 39-41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu ('078) in view of Szwejkowski ('499) further in view of Wu ('US 2003/0181055).

Liu ('078) teaches a method of using amorphous carbon (APF) in the etching of a substrate. Liu ('078) discloses a structure that consists of a substrate on which an amorphous carbon layer and then a layer of photoresist are deposited. (Col.5, 15-43; Fig. 2B). The features patterned into the photoresist layer are transferred to the amorphous carbon layer by a plasma etch, the photoresist is removed and then the features patterned into the amorphous carbon layer are patterned into the substrate using the carbon layer as a hard mask. (Col.5, 15-43). This disclosure teaches the limitations of claim 1-2, 7, 9-11, 24, 29, and 39-41, where a carbon containing hard mask over a substrate is patterned with a carbon rich patterned resist, where the carbon rich resist is removed after etching a pattern in the carbon-containing hard mask, where patterning the hard mask includes patterning amorphous carbon, and where the substrate is then patterned by a dry etch method through the hard mask.

Liu ('078) also teaches the structure disclosed may include a non-carbon based dielectric layer that is deposited over the amorphous carbon layer before the photoresist layer is deposited, which can also act as an antireflective coating (ARC). (Col. 5, 56- col. 6, 45; Fig.3A-3F). However, Liu ('078) fails to teach a process step where the surface of the substrate is treated, after removing the carbon rich patterned resist, with a solution to remove residual carbon rich resist disposed in contact with the substrate under conditions that are not damaging to the underlying layers. Szwejkowski ('499) discloses a method, which teaches such process steps.

Szwejkowski ('499) discloses a method to remove sidewall residues remaining after a polysilicon layer that has been masked with a photoresist layer is etched. The residues from the etch process are removed without undercutting the remaining polysilicon, using a solution of ammonium hydroxide and peroxide. (Col.2, 26-39 and 57-col.3, 2). This disclosure teaches the limitation of claims 1-11, 24-29, 31-34 and 40-41 where the substrate is treated with a solution of ammonium hydroxide and peroxide, after the patterned carbon rich photoresist has been removed, to remove residual carbon rich resist disposed in contact with the substrate under conditions that are not damaging to the underlying layers.

Szwejkowski ('499) also teaches the solution of aqueous hydrogen peroxide and ammonium hydroxide has a concentration ratio by volume of about 1 part hydroxide to 2 parts peroxide to 7 parts water, which is within the concentration ratio ranges recited in claims 3-4 and 10. (Col. 3, 38-40). Moreover, this disclosure meets the limitation of claims 31-34 where the solution has a volume concentration ratio of 5:1:1 of H_2O: NH_4OH: H_2O_2.

Szwejkowski ('499) further discloses the solution is heated and maintained between about 50°C – about 70°C (Col.3, 45-49), and the substrate is in the solution for about 5 seconds to about 15 minutes to remove the excess residue. (Col.3, 50-57). These teachings fall within the time and temperature ranges, which are between about 2 to about 45 minutes and between about room temperature to about 70°C, recited in claims 7-9, 11, 26-28, 30, 34, and 41 for applying the solution of ammonium hydroxide and peroxide or a solution that is comprised of ammonium hydroxide and peroxide and other components to the substrate.

Still Liu ('078) in view of Szwejkowski ('499) does not explicitly disclose that after the patterned carbon rich resist is removed the substrate is surface treated to remove residual carbon

rich resist in contact with at least one of the top surface of the hard mask and the substrate under conditions that are selective to the hard mask and to the substrate. However, Wu ('055) discloses such process steps.

Wu ('055) disclose a method of removing photo-resist and polymer residue from a dielectric layer that includes a wet strip process for removing a resist layer used to pattern a underlying dielectric layer after which a solution to remove remaining residue is applied. (Abstract). Wu ('055) discloses that the key to the process is to completely remove the sidewall polymer fence or resist residue that remains on the dielectric layer without damaging an underlying to be patterned layer such as the dielectric layer. (Abstract).

Wu ('055) discloses the process comprises removing photoresist and then the polymer residue that forms undesirable as a result of using a photoresist mask to pattern at least a layer beneath. (Para, 0014). Wu ('055) discloses the method comprises the steps of applying a SC1 solution of ammonium hydroxide, sulfuric acid and water and applying a CR solution which substantially comprises sulfuric acid and hydrogen peroxide. (Para, 0014). Wu ('055) discloses the strip process of the resist and the polymer residue is conducted after a pattern etching process is performed. (Para, 0022). This disclosure meets the limitation of claims 1, 7, 24, 29 and 39 where the patterned carbon rich resist is removed. Wu ('055) also discloses the SC1 solution is used to remove the sidewall polymer fence and the CR solution removes the photoresist mask. (Para, 0027).

Wu ('055) also discloses two embodiments that successfully remove the photoresist and the polymer residue that remains. In one embodiment the CR solution is applied before the SC1 solution and in the other embodiment the SC1 solution is applied before the CR solution. (Para,

0028). This disclosure meets the limitation of claims 1, 7, 24, 29 and 39 where the substrate is surface treated after the carbon rich patterned resist is removed to remove residual carbon rich resist disposed in contact with at least on of the top surface of the hard mask and the substrate under conditions that are selective to the hardmask and the substrate.

It would have been obvious to one of ordinary skill in the art at the time of invention by applicant to modify the teachings of Liu ('078) in view of the teachings of Szwejkowski ('499) further in view of Wu ('055) because polysilicon and carbon are in the same chemical series; therefore, it is obvious the cleaning solution and process disclosed in Szwejkowski ('499), used on a polysilicon layer can be used on a carbon layer to remove carbon rich photoresist residue, while leaving the underlying layers undamaged and Wu ('055) teaches that a two step strip process can be implemented to remove residual carbon rich resist without damaging underlying to be patterned layer.

6. Claims 5-6, 11 and 25-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu ('078) in view of Szwejkowski ('499) further in view of Wu ('055) as applied to claims 1-4, 7-10, 24 and 39-41 in paragraph 10 above, and further in view of Chen ('435).

Liu ('078), Szwejkowski ('499) and Wu ('055) fails to disclose solutions of ammonium hydroxide and peroxide that may include other components (claims 25-29 and 32-34) with a volume concentration ratio of about 100:3:2 (claims 11 and 31-34) or a volume concentration ratio that ranges from about 100:1:2 to about 100:3:2 (claim 5) or from about 100:1:1 to about 100:3:3 (claim 6), H_2O: NH_4OH: H_2O_2. Dilute solutions of ammonium hydroxide and hydrogen peroxide, which may include other components, and are used as cleaning solutions, are disclosed in Chen ('435).

Chen ('435) discloses a method of cleaning or stripping photoresist from photomasks by using solutions of ammonium hydroxide and hydrogen peroxide. In one embodiment Chen ('435) discloses applying a very dilute solution of ammonium hydroxide and hydrogen peroxide, with volume concentration ratios of 1:2-10:200-1000 that can be simplified to a ratio of .5:1-5:100-500, at low temperatures to clean or strip photoresist from a photomask. (Para, 0024). This disclosure meets the limitation of claims 5-6, 11, 31-34 and 42, where solutions of ammonium hydroxide and hydrogen peroxide that may also contain other components, have a volume concentration ratio of 100:3:2 (claims 11 and 31-34), or a volume concentration ratio that ranges from about 100:1:2 to about 100:3:2 (claim 5) or from about 100:1:1 to about 100:3:3 (claim 6), H_2O: NH_4OH: H_2O_2.

Liu ('078), Szwejkowski ('499) and Wu ('055) also fail to disclose treatment solutions of ammonium hydroxide and peroxide that may contain other components such as those recited in claims 25-29 and 33-34. Treatment solutions such as these are also taught in Chen ('435).

Chen ('435) discloses various solutions, which can be used to clean or strip resist from a photomask. One solution is comprised of an aqueous dilute solution of ammonium hydroxide and hydrogen peroxide (dAPM). (Para, 0024 and 0027). One solution is comprised of sulfuric acid and ozone (SOM). (Para, 0020) Both components of this solution are recited in claims 25-29 and 32-34 as components that may be included in the treatment solution. The other solution is comprised of sulfuric acid and hydrogen peroxide (SPM), which includes components that are recited in claims 25-29 and 32-34 as other components of the treatment solution. (Para, 0034). Chen ('435) further discloses the various solutions can be combined and applied to the structure to strip or remove photoresist. (Para, 0034 and 0043). This disclosure in Chen ('435) teaches the

limitation of claims 25-29 and 32-34 where the treatment solution can be comprised of various combinations of solutions including for example aqueous solutions of ammonium hydroxide and hydrogen peroxide (dAPM) and sulfuric acid and hydrogen peroxide (SPM).

It would have been obvious to one of ordinary skill in the art at the time of invention by applicant to modify the combination of Liu ('078), Szwejkowski ('499) and Wu ('055) in view of the teachings of Chen ('435) because Chen ('435) teaches dilute solutions of ammonium hydroxide and hydrogen peroxide, that may include other components, can be used to remove residual resist from a photomask and leave the underlying layers undamaged.

7. Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over Liu ('078) in view of Szwejkowski ('499) further in view of Wu ('055) as applied to claims 1-4, 7-10, 24 and 39-41 in paragraph 10 above and further in view of Fang ('338).

Liu ('078), Szwejkowski ('499) and Wu ('055) fail to disclose treatment solutions of sulfuric acid and citric acid that may include other components, with a volume concentration ratio range of about 100:3:2 to about 100:2:2 (claim 42), H_2O: H_2SO_4: $C_6H_8O_7$. Solutions comprised of sulfuric acid and citric acid that include other components are disclosed in Fang ('338).

Fang ('338) teaches a method to deposit a cobalt containing capping layer. As part of this process there is a pre-clean step where the substrate is exposed to a complexing agent solution to remove oxides or other residues such as organic residues, resist, and other polymeric residues from previous fabrication processes. (Para, 0028). This pre-clean step is analogous to the step where the substrate is treated with a solution to remove residual carbon rich resist without damaging the underlying layers. The complexing agent is a solution that consists of at least one

acid, a pH adjusting agent and other additives including citric acid and other acids such as sulfuric acid. (Para, 0029).

One exemplary complexing agent solution disclosed in Fang ('338) is comprised of water, citric acid in a concentration ratio of .05M to about 1.0M, EDTA, sulfuric acid in a concentration of .05N to about 1.0N and TMAH or ammonium in a concentration to adjust the pH to a range from about 1.5 to 10. (Para, 0030). This disclosure meets the limitation of claim 42 where the surface treating solution is comprised of sulfuric acid and citric acid. Although Fang ('338) does not disclose the volume concentration ratio recited in claim 42, one of ordinary skill in the art would be able to determine the appropriate volume concentration ratio to achieve a solution that would remove residual resist without damaging the underlying layers.

It would have been obvious to one of ordinary skill in the art at the time of invention by applicant to modify the combination of Liu ('078), Szwejkowski ('499) and Wu('055) in view of the teachings of Fang ('338), because Fang ('338) teaches that one can remove residual resist from structures such as the ones disclosed in Liu ('078) or Wu ('055) with the solutions disclosed to prepare the structure for further processing without damaging the underlying layers of the structure.

Response to Arguments

8. Applicant's arguments filed 09/12/08 have been fully considered but they are not persuasive.

9. Applicant argues in the prior art reference of Liu ('078) there is no suggestion of a problem with residual resist material remaining after the removal of photoresist, and in the Szwejkowski ('499) reference there is no suggestion the silicon oxide film removed is

photoresist. Applicant also argues while Wu does suggest a method of removing photoresist fence from an oxide layer with a method that improves organic resist to oxide removal rates, this reference combined with the teachings of Liu and Szwejkowski fails to teach the limitation of the claims pending in the current application where, "... surface treating the substrate after removing the carbon rich pattered resist to remove residual carbon rich resist disposed in contact with at least one of the top surface of the hard mask and the substrate under conditions that are selective to the hard mask and to the substrate..." However, Examiner is of the position the combination of references does teach and or suggest the limitations of the claims as amended.

10. Examiner notes Applicant agrees and/or understands the combination of references suggest the use of an organic resist, especially the prior art reference Wu. Examiner also submits Applicant's amendment to claims 1, 7, 24, 29 and 39 to include the language carbon rich resist, is supported by the disclosures in the specification. However, Examiner is of the position Applicant has failed to define or describe carbon rich resist in a manner distinguishing such a resist from the organic resist materials suggested and /or taught by the prior art currently applied to claims 1, 7, 24, 29 and 39. Therefore Examiner is of the position the combination of references encompasses the use of a carbon rich resist material.

11. Examiner also maintains Liu ('078) was not relied upon as teaching the limitation where residual resist remained after the photoresist material was stripped. Examiner relied upon the disclosures of Szwejkowski as teaching the step of removing residual resist material. Examiner maintains while Szwejkowski ('499) does not explicitly state the polymeric silicon oxide-containing residue on the polysilicon layer is resist, it is inherent the residue includes resist material, which remains from the process where the resist layer is used as an etch mask for the

underlying polysilicon layer and is removed, although not to completion when the underlying polysilicon layer is patterned using the overlying patterned resist layer as an etch mask. The residue, which contains resist material, is then removed when the structure is exposed to the hydroxide/peroxide solution. Moreover, Applicant assumes the etching step using the resist layer as a mask removes all the resist material when used to pattern the underlying polysilicon layer, which is material known to comprise hard mask layers in semiconductor device manufacturing processes. Therefore, Examiner maintains Liu ('078) in view of Szwejkowski ('499) does suggest removing resist residue after the patterned resist is removed. Moreover, Examiner finds the teachings of Liu ('078) in view of Szwejkowski ('499) in view of the teachings of Wu ('055) which are explicitly directed to stripping an organic photoresist mask and removing the remaining organic photoresist residue that results from using the organic photoresist mask to pattern an underlying layer teaches all the limitations of the claims as amended.

12. Applicant also argues, while Chen ('435) is used to demonstrate solutions of ammonium hydroxide and peroxide are known, it does not cure the failure of the other references to suggest a surface treatment to remove residual carbon rich resist material. However, as discussed in paragraph 11 above, Examiner is of the position the combination of Liu, Szwejkowski and Wu teaches removing a carbon rich patterned resist and surface treating the substrate after removing the patterned carbon rich resist to remove residual carbon rich resist under conditions that are selective to the hard mask and the substrate. Therefore, Liu ('078) in view of Szwejkowski ('499) further in view of Wu ('055) and further in view of Chen ('435) does disclose, teach and/or suggest all the limitations of claims 5-6, 11, 25-29 and 31-34.

13. Applicant further argues the remaining dependant claims are patentable because they depend from patentable independent claims. However, as Examiner has maintained above, independent claims 1, 7, 24, 29 and 39 are not patentable over the prior art teachings of Liu ('078) in view of Szwejkowski ('499) further in view of Wu ('055); therefore, Examiner is of the position the rejection(s) of the remaining dependant claims are properly maintained.

14. Lastly, Applicant argues while Fang ('338) is used to demonstrate solutions including sulfuric acid and citric acid are known, it does not cure the failure of Liu ('078) and Szwejkowski ('499) and Wu to teach all the limitations of the claims from which claim 42 depends. However, as discussed in paragraph 11 above Examiner maintains the position the combination of Liu, Szwejkowski, and Wu does teach a step of, "...surface treating the substrate to remove residual carbon rich resist after removing the pattern carbon rich photoresist..." Therefore, Examiner finds the rejection of claims 42 over the combination of Liu ('078), Szwejkowski ('499) and Wu ('055) in view of Fang ('338) is properly maintained above.

Conclusion

15. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period

will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to CALEEN O. SULLIVAN whose telephone number is (571)272-6569. The examiner can normally be reached Monday-Friday, 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/COS/, 12/15/08.

/Mark F. Huff/
Supervisory Patent Examiner, Art Unit 1795